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(54) **Anti-static material and process.**

(57) Expanded cellular or foamed thermoplastic cups and containers commonly are readily statically charged and this causes problems, particularly in drink dispensing means.

Articles of such material can be made substantially static free by use of a selected surface active agent or emulsifier which may be applied to the surface of the article or to the beads of thermoplastic material from which the article is made.

In a process of combining anti-static agent and thermoplastic material, an anti-static agent, which may be liquid or solid, is misted, atomised or vapourised for coating beads of a thermoplastic material, the beads at the coating stage being unexpanded or pre-expanded.

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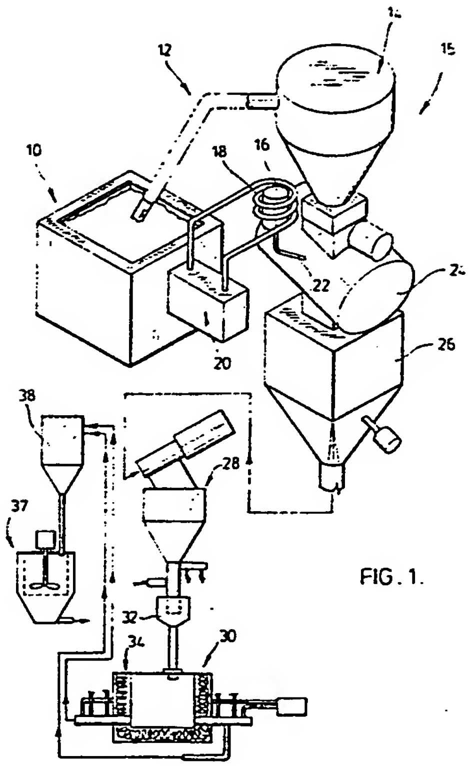

FIG. 1.

"ANTI-STATIC MATERIAL AND PROCESS"

This invention relates to substantially static free, cellular expanded or foamed thermoplastic articles, including cups and containers, and processes for the manufacture of these articles including the manufacture of intermediate materials suitable for use in such manufacture.

Expanded cellular or foamed thermoplastic cups and containers have been known in the art for some time. They are normally moulded from expanded polystyrene, prepared from expanded polystyrene beads, initially containing approximately 5% by weight of hydrocarbon blowing agent. The closed cell structure of the expanded polystyrene cups, for example has a density of around 4 - 6 lbs./cu.ft. the cups having an internal volume of about 200 cubic centimetres and a weight from slightly less than about two grams to greater than about three grams, to provide a desired degree of thermal insulation. The processing of the cups from the polystyrene beads involves pre-expansion of the beads, the addition of a small percentage by weight of a moulding/fusion lubricant (commonly zinc stearate), the aging of the beads under regulated conditions to allow equilibration of the blowing agent, and finally, the deposition of the pre-expanded beads into a cup mould for fusion by the application of heat. During the moulding operation, the initially spherical pre-expanded polystyrene beads expand further and fuse to each other, assuming for example, a dodecahedral shape, yielding a leakproof moulded cup.

Conventional zinc stearate lubricated, moulded expanded polystyrene cups exhibit dielectric characteristics similar to polystyrene and are readily statically charged, causing deposited powdered comestibles to stick to the sides and nested cups in a stack to stick together preventing their separation when one is to be dispensed from the stack.

In many instances, the electrostatic force between the cups is greater than the stripping or discharge force applied to drop the

lowermost cup from the stack of cups. Particularly, expanded cellular or foamed thermoplastic cups which weigh in the order of about 1.8 grams are impeded by the slightest electrostatic forces keeping the cups together, from dropping from the stack of cups down the chute. Additionally, because of the static charge adhering to the cup side wall, comestible deposited in the lower cup tends to cling to the inner side wall so that comestible in contact with the outer side wall of the upper adjacent cup is transferred to the outer side wall of the cup.

A number of approaches have been proposed to reduce or eliminate static entirely. See for example, U.S. Patents 3,206,429, 3,236,681; 3,595,464 and 3,796,366. U.S. Patent 3,206,429 teaches improved polyethylene compositions containing N,N-diethanol oleamide which compositions are purported to exhibit improved anti-static properties. The compositions can be prepared by dissolving the N,N-diethanol oleamide in isopropanol or other suitable solvent and externally coating polyethylene pellets by thoroughly mixing the pellets and solution in any suitable tumbling or stirring type mixer. The coated pellets are then formed, by any of the conventional methods, into moulded objects or film exhibiting the desired anti-static properties.

This approach was carried over in U.S. Patent 3,236,681 to the manufacture of articles consisting of foamed thermoplastic materials (in one example expandable polystyrene particles). U.S. Patent 3,236,681 discloses a process of coating expandable thermoplastic polymer particles with a film of an aqueous solution of an anti-static agent comprising a salt of an alkyl diacid phosphate of the formula $X(RHPO4)n$, where X may be for example, ammonium or alkali metal, n may be 1-3, and R may be an alkyl moiety containing 1-18 carbon atoms (for example ammonium amyl hydrogen phosphate). The coated particles are then dried and then prefoamed by passing them under an infrared heater.

As a critical feature of the invention, the patent teaches

deposition of at least 0.01% of the salt of an alkyl diacid phosphate on the surfaces of the expandable polymer particles based on the weight of the polymer particles with the preferred quantity being in the range of about 0.01% to about 0.1%. Where it is desired to have deposited thereon in the dried state an amount in excess of 0.10% of the salt of an alkyl diacid phosphate, the patent teaches the incorporation of a sulfate salt with the anti-electrostatic agent, to prevent agglomeration.

While U.S. Patent 3,236,681 teaches the coating of expandable polystyrene particles with an anti-static agent and prefoaming the coated particles for further processing, U.S. Patent 3,595,464 specifically relates to foamed polystyrene cups and teaches the coating of the particles with a detergent (for example aluminum lauryl sulfate and an organic amide builder) by for example, tumbling the beads in some sort of container and adding the detergent in liquid form, for fully coating the entire surface of all the beads, prefoaming the coated beads and then charging them into a mould for manufacturing a foam polystyrene cup. The patent then teaches that by this process, the surfaces of foamed polystyrene cups may be considered to be covered with film as well as the interface between adjacent fused beads through the walls and bottoms of the cups.

U.S. Patent 3,796,366 discloses a different approach, teaching the application of an aqueous non-ionic emulsion of polyethylene and thence subjecting the article to drying conditions to remove substantially all the water therefrom.

The difficulty with these approaches with respect to the pre-foaming or foaming of thermoplastic polystyrene particles relates to the amount of anti-static eventually covering the bead when the bead is pre-expanded or expanded. As the beads expand, the thickness of the film reduces with some of the film, vaporizing when the coated bead is injected into the heated pre-expander resulting in a reduction in the film of anti-

static agent covering the bead.

It is an object of this invention to provide articles, and processes suitable for use in the manufacture, of substantially static free expanded, cellular or foamed thermoplastic articles (for example, cups and containers) which overcome the aforementioned difficulties with the prior art and which employ anti-static agents suitable for use with comestibles. In this regard not all detergents (for example disclosed in U.S. Patents 3,236,681 and 3,595,464) are suitable as anti-static agents let alone suitable for use in association with comestibles.

It is a further object of the invention to combine thermoplastic material with anti-static agents suitable for use in association with commestibles, for use in the processes.

According to one aspect of the invention, a process of combining an anti-static agent with thermoplastic bead to be pre-expanded for use to manufacture a static free article of cellular expanded or foamed thermoplastic material, or, fully expanded into a static free article of cellular expanded or foamed thermoplastic material is provided, the anti-static agent being suitable for use with commestibles and being combined in sufficient amounts, either:

(a) with thermoplastic bead to be expanded prior to injection into a pre-expander and thereafter injecting the combination into the preheated pre-expander for pre-expanding the bead; or

(b) with the bead in a preheated pre-expander shortly after injection of the bead into a preheated pre-expander for pre-expanding the bead; or

(c) in liquid form, with steam for delivery to a moulding cavity of a mould for intermixing with pre-expanded bead for moulding into the final article, whereby the anti-static agent upon contacting the heated environment is misted, atomized and/or vaporized, filling the space of the environment, uniformly coating the expanding bead and rendering the material anti-static. Because many of the suitable surface active agents or emulsifiers are solids, have melting points slightly above, or at, room or ambient temperature, and become somewhat sticky at room or ambient temperature, they may be maintained in a refrigerated environment until ready for use. In solid form, they may be cryogenically ground into a fine powder and refrigerated until used.

Therefore where the anti-static agent is in solid form and is combined with the bead outside of the pre-expander, the mixing with bead is accomplished at a temperature and in a form (for example small particles) to permit the mixing thereof (for example, in the case where the solid anti-static agent melts at a temperature slightly above or at room or ambient temperature), the solid is maintained at a temperature below its melting point or point whereat it becomes sticky (and where required, ground into an appropriate size), and thereafter, the mixture as combined is heated (in for example, a preheated pre-expander) to a temperature to permit expansion of the beads and the atomizing, misting or vaporizing of the solid anti-static agent filling the space of the environment, uniformly coating the expanding beads.

In some instances, the anti-static agent (solid surface active agent or emulsifier) may be acquired as a solid block. In that event, the material may be cryogenically ground and maintained at a temperature so it does not become sticky or melt. If the material comes as a powder or is flaked, it may be added to the bead mixture and mixed therewith at a temperature to prevent melting or sticking of the anti-static material and thereafter, injecting the combination into the pre-expander where

the anti-static agent is atomized, misted or vaporized in the mixture to uniformly coat the bead as it expands to the desired density.

If the anti-static agent to be combined with the bead is in liquid form, and is to be mixed with the bead prior to being added to the heated pre-expander, the anti-static agent is mixed with the bead and thereafter the combination heated (as for example, being injected into the pre-expander) to permit the expansion of the beads and the atomizing, misting or vaporizing of the liquid anti-static agent filling the space of the environment uniformly coating the expanding bead.

If the anti-static agent to be combined with the bead is in liquid form, the liquid anti-static agent may also be injected into a heated environment (for example a preheated pre-expander) separately from the bead wherein it atomizes, mists or vaporizes filling the environment uniformly coating the expanding bead when added.

In this instance, the liquid anti-static agent may be metered into a heated pre-expander to which a premeasured amount of bead is added.

Because pre-expansion takes place at a temperature of between about 275 degrees F (about 135 degrees C) to about 300 degrees F (about 149 degrees C), the metered liquid, sprayed into the pre-expander and heated to the suitable temperature, mists, vaporizes, or atomizes uniformly coating the bead as the bead expands.

Where the thermoplastic material has been pre-expanded with the anti-static agent, the coated pre-expanded bead is then stored for use in the final expansion process during moulding. When employed in the final moulding process, the anti-static agent coating the bead may also act as a lubricant in the mould.

It is also to be appreciated the beads of thermoplastic material used in the processes contain the necessary volatile blowing agent to enable expansion.

If the thermoplastic bead has been pre-expanded without the

anti-static agent, a predetermined amount of anti-static agent may be injected (in liquid form) into the line carrying the steam to the moulding cavity of the mould, wherein it vaporizes, mists or atomizes filling the mould coating the pre-expanded bead material during final expansion of the bead to form the final moulded product.

Preferably, when the anti-static agents are added to the bead to be expanded either prior to, or during, pre-expansion, or added in liquid form during final expansion, the said agents are added in amounts of, or in excess of, .1% by weight, and preferably in excess of about .2% by weight. Amounts of anti-static agent added of about .5% by weight of the beads to be expanded also provide satisfactory results. So do amounts in excess of 1%, 1.5% and 2%. While acceptable results are obtained when the anti-static agent is added in amounts to about 5% by weight of the beads to be expanded, the costs of the anti-static agent may deter such amount from being added. In amounts of about 6.25% of anti-static agent to the weight of the bead, the results were not as acceptable. Particularly, the flow characteristics of the bead so treated was not as acceptable for proper fusion for the formation of the articles. Some quality problems at these percentages may be overcome however, by the use of a pressure fill system but the use of such system would make the product so manufactured not cost effective. The flow characteristics of the bead so treated may also be enhanced by the addition of zinc stearate, but the costs of manufacture would also make the product not cost effective.

If too much anti-static agent is added, the moulded product also sticks in the mould. Therefore, when pre-expanded bead is combined with the anti-static agent in the mould, the amount of anti-static agent intermixed is controlled to ensure minimal sticking.

While agent added in an amount much less than about .1% by weight reduces static slightly, the static dependent upon the amount of

anti-static agent added would not be reduced sufficiently to give a satisfactory static free article.

According to another aspect of the invention, we have found that, unexpectedly, a non-ionic, anionic, cationic, amphoteric surface active agent or emulsified, may be used as an anti-static agent in the manufacture of substantially static free articles, for example, cups or containers of cellular expanded or foamed thermoplastic material comprising beads of cellular expanded or foamed thermoplastic material moulded in the shape of the article, for example, cups or containers, and suitable for use in association with comestibles, such agent or emulsifier being selected from:

1. fatty acid dialkylolamides for example, lauric diethanolamide, coconut diethanolamide, myristic diethanolamide and stearic diethanolamide;

2. higher fatty acid esters of polyglycerols for example, polyglycerol esters of palmitic or stearic acids for example, stearic or palmitic polyglycerol;

3A. monoethanolamine lauryl sulphates;

3B. lauryl ether sulphates;

4. higher alcohol ethoxylates;

5. quaternized ethoxylated amines;

6. fatty acid ester ethoxylates for example, unsaturated fatty acid ester ethoxylates for example polyethylene glycol monostearate;

7. higher fatty acid esters of glycerol for example, glyceryl monostearate;

8. higher amine oxides;

9. aliphatic sulphonates;

10. citric acid esters of monoglycerides;

11. a 2-alkyl-1-[ethyl-betaoxypropanoic acid]-imidazoline;

12. alkyl dimethyl betaines;

13. lauroyl sarcosinates;

14. higher ethoxylate sorbitan esters of a higher fatty acid, for

example, polyoxyethylene sorbitan monostearate;

15. castor oil ethoxylates (ethoxylated castor oil);

16. hydrogenated castor oil ethoxylates (ethoxylated hydrogenated castor oil);

17. fatty acid esters of lactylates for example, a lactylate ester of stearic or palmitic acid.

Thus a substantially static-free article (e.g.a cup or container) of cellular expanded or foamed thermoplastic material comprising beads of cellular expanded foamed thermoplastic material moulded in the shape of the article and at least one of the non-ionic, anionic, cationic or amphoteric surface active agents or emulsifiers as described suitable for use with comestibles is provided.

The suitable anti-static agent may be coated on the surface of a preformed article, for example, cup or container, in the form of a heavy emulsion sprayed under pressure onto the article (cup or container) or portion of the article (cup or container) or by any other suitable method of application (as by brushing on with a brush). The suitable agent may also be mixed with thermoplastic bead (prior to expansion) to coat the bead. In this regard, the bead may be coated by mixing with a sufficient amount of the suitable active agent or emulsifier in liquid form or by tumbling the bead with flakes or powder of the surface active agent or emulsifier to coat the beads.

Therefore, according to another aspect of the invention, the combination of thermoplastic material and at least one anti-static non-ionic, anionic, cationic, amphoteric surface active agent or emulsifier suitable for use in association with comestibles selected from:

1. fatty acid dialkylolamides;

2. higher fatty acid esters of polyglycerols;

3A. monoethanolamine lauryl sulphates;

3B. lauryl ether sulphates;

4. higher alcohol ethoxylates;

5. quaternized ethoxylated amines;

6. fatty acid ester ethoxylates;

7. higher fatty acid esters of glycerol;

8. higher amine oxides;

9. aliphatic sulphonates;

10. citric acid esters of monoglycerides;

11. a 2-alkyl-1- ethyl-betaoxypropanoic acid -imidazoline;

12. alkyl dimethyl betaines;

13. lauroyl sarcosinates;

14. higher ethoxylate sorbitan esters of higher fatty acid;

15. castor oil ethoxylates (ethoxylated castor oil);

16. hydrogenated castor oil ethoxylates (ethoxylated hydrogenated castor oil);

17. fatty acid esters of lactylates,

is provided.

However, the preferred method of application comprises the combination of a sufficient amount of an anti-static agent as previously described:

(a) with thermoplastic bead to be expanded prior to injection into a pre-expander and thereafter injecting the combination into the preheated pre-expander for pre-expanding the bead, or

(b) with the bead shortly after injection of the bead into a preheated pre-expander for pre-expanding the bead, or

(c) in liquid form, with steam for delivery to a moulding

cavity of a mould for intermixing with pre-expanded bead for moulding into the final article, whereby the anti-static agent upon contacting the heated environment is misted, atomized, and/or vaporized filling the space of the environment uniformly coating the expanding bead and rendering the material anti-static.

Suitable anti-static agents include:

1. fatty acid dialkylolamides preferably prepared from a:

(i) lauric diethanolamide

(ii) coconut diethanolamide

(iii) myristic diethanolamide

(iv) stearic diethanolamide

Examples of suitable lauric diethanolamides are marketed under the trade marks:

(a) Lankrostat J.P. (by Diamond Shamrock U.K. Ltd.)

(b) REWO AMID DL 203/S (By Rewo Chemicals Ltd.)

(c) EMPILAN LDX (By Albright & Wilson Ltd.) (Lauric Diethanolamide 2:1)

(d) MARLAMID D1218* (By Huls U.K. Ltd.)

(e) EMPILAN LDE (by Albright & Wilson Ltd.) (Lauric Diethanolamide 1:1).

(f) EMPILAN CDE-FF* (Lauric Diethanolamide 1:1)

Examples of suitable coconut diethanolamides are marketed under the trade marks:

(a) MARLAMID D1218*

(b) EMPILAN CDE/FF*

*(described in the literature as both)

An example of a suitable myristic diethanolamide is marketed under the following trade mark:

(a) MONAMID 150MW (By DF Anstead Ltd., Mona Industries, U.S.A.)

An example of a suitable stearic diethanolamide is marketed under the trade mark:

(a) MONAMID 718 (By DF Anstead Ltd., Mona Industries, U.S.A.)

2. Higher fatty acid esters of polyglycerols for example, polyglycerol esters of palmitic or stearic acids comprising:

(i) stearic/palmitic ester of polyglycerol

Examples of stearic/palmitic esters of polyglycerols are marketed under the trade marks:

(a) GRINDTEK PGE 55 (By Grinsted Products Ltd.)

(b) GRINDTEK PGE 55/6 (By Grinsted Products Ltd.)

3. (a) Monoethanolamine lauryl sulphates. An example of a suitable monoethanolamine lauryl sulphate is marketed under the trade mark: EMPICOL LQ 33T.

(b) lauryl ether sulphates.

4. Higher alcohol ethoxylates for example:

(i) a liquid ethoxylate of oleyl alcohol having an H.L.B. No. of 9.0 for example marketed under the trademark VOLPO 05;(Croda Chemicals Ltd.)

(ii) an ethoxylate of oleyl/cetyl alcohols having an H.L.B. No. of 12.7 for example, marketed under the trade mark LUBROL 17A10 (By Imperial Chemical Industries Ltd.)

5. Quaternized ethoxylated amines for example:

(i) quaternized coconut amine ethoxylate.

An example of a quaternized ethoxylated amine is marketed under the trademark Ethoquad C12 (by Armour Hess Chemicals Ltd.)

6. Fatty acid ester ethoxylates for example,

(i) unsaturated fatty acid ester ethoxylates marketed under the trademark TEXOFOR C1 (by ABM Chemicals Ltd.)

(ii) polyethylene glycol monostearate,

(iii) polyethylene glycol mono oleate.

(An example of polyethylene glycol mono stearate is marketed under the trademark CITHROL 10 MS).

7. Higher fatty esters of glycerol, for example:

(i) glyceryl monostearate.

An example of a glyceryl monostearate may comprise:

(i) glycerol monostearates marketed under the trademarks EMPILAN GMS SE40 and EMPILAN GMS NSE40 by Albright & Wilson Ltd.

8. Higher amine oxides for example:

(i) a cocoyl amine oxide marketed under the trademark EMPIGEN OB by Albright & Wilson Ltd.

9. Aliphatic sulphonates, for example:

(i) a product marketed under the trademark HOSTASTAT HS-1 (by Hoechst U.K. Ltd.).

10. Citric acid esters of monoglycerides, for example:

(i) a neutralized citric acid ester of monoglyceride made from edible refined hydrogenated fat comprising the main fatty acids, palmitic acid and stearic acid marketed under the trademark GRINDTEK-CA-P+ (by Grinsted Products Ltd.).

11. A 2-alkyl-1-[ethyl-betaoxypropanoic acid]-imidazoline, for example:

(i) a product marketed under the trademark CRODATERIC C.

12. Alkyl dimethyl betaines, for example:

(i) a dodecyl dimethyl betaine marketed under the trademark AMBITERIC D40.

13. Lauroyl sarcosinates, for example:

(i) lauroyl sarcosine marketed under the trademark CRODASINIC

14. Higher ethoxylate sorbitan esters of higher fatty acids for example:

(i) polyoxyethylene sorbitan monostearate.

A stearic/palmitic ester of ethoxylated sorbitan is a monoester

marketed under the trademark CRILLET 3.

15. A castor oil ethoxylate (ethoxylated castor oil) for example:

(i) marketed under the trademark ETHOCAS 35.

16. A hydrogenated castor oil ethoxylate (ethoxylated hydrogenated castor oil) for example, marketed under the trademark CRODURET 30.

17. Fatty acid esters of lactylates, for example,

(i) a lactylate ester of stearic or palmitic acid or stearic/palmitic esters of lactic acid, including:

(a) sodium steroyl-2-lactylate marketed under the trademark GRINDTEK FAL-1 by Grindsted Products Ltd.

The invention will now be illustrated with reference to the following drawings and discussions of examples of embodiments of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 illustrates pre-expansion equipment used to coat beads of thermoplastic material to be expanded, with an anti-static surface agent or emulsifier according to one embodiment of the invention.

Figure 2 illustrates pre-expansion equipment used to coat beads of thermoplastic material to be expanded, with an anti-static surface active agent or emulsifier according to another embodiment of the invention.

Figure 3 is a cross-sectional view through moulding equipment used to expand pre-expanded beads with an anti-static agent according to another aspect of the invention.

DETAILED DESCRIPTION OF DRAWINGS AND EMBODIMENTS

With reference to Figure 1, there is shown storage bin 10 containing beads of polystyrene containing a blowing agent in such proportions as are necessary for expansion. Intake tube 12 takes bead into hopper 14 of Conair Preblender 15. Solid anti-static agent,

(lauric diethanolamide), in powder form is maintained in refrigerated storage container 16 at a temperature below which the agent melts or becomes sticky, by coils 18 of refrigeration unit 20. Anti-static material is metered through inlet tube 22 into mixing chamber 24 at a rate of .5% by weight of anti-static agent lauric diethanolamide material to the thermoplastic bead (with blowing agent) fed into chamber 24 to be mixed therewith. The mixed material is then collected in chute 26 and fed into inlet hopper 28 of pre-expander 30. The mixed material is maintained refrigerated and is premeasured in sight glass 32 for addition to pre-expansion chamber 34 wherein pre-expansion of the bead takes place at a temperature of between about 275 degrees F (135 degrees C) and about 300 degrees F (149 degrees C). At that temperature the solid anti-static material, it is thought, quickly vaporizes, atomizes or mists, filling the chamber. As the expanding bead fills the chamber, the bead is uniformly coated by mist. After the pre-expansion process, the covered pre-expanded bead is conducted to hopper 35 and fed to sizer 37 - the undersized being returned for reprocessing.

With reference to Figure 2, pre-expansion equipment 40 has been provided for coating and covering the bead to be expanded with anti-static agent lauric diethanolamide in liquid form. In the equipment shown in Figure 1, solid anti-static agent was fed into mixing chamber 24 with bead fed from hopper 14. In the embodiment shown in Figure 2, Conair System Preblender 15 is unnecessary and the liquid anti-static agent is premeasured directly into pre-expansion chamber 34 through inlet 52, from storage container 50 in an amount of about .5% by weight of the bead to be expanded. Except for this modification, the equipment illustrated in Figure 2 is the same as in Figure 1. Therefore, with respect to the embodiment illustrated in Figure 2, bead is fed directly from storage bin 10 by inlet tube 12 into hopper 28 and ultimately into preheated expansion chamber 34 as the premeasured liquid anti-static

agent is metered from storage 50 through inlet 52 into chamber 34. When added to the preheated chamber the liquid anti-static agent quickly vaporizes, atomizes and mists, filling the chamber covering the expanding bead. After pre-expansion, the pre-expanded bead is moved to storage for later use in moulding articles, for example, foamed cups and containers.

For illustration, the following anti-static agents are presented as suitable for use with polystyrene bead for the coating thereof in a pre-expansion process illustrated with reference to Figures 1 and 2 ultimately used to manufacture foamed cups and containers.

(a) Lankrostat J.P. (t.m.) by Diamond Shamrock (a non-ionic lauric diethanolamide);

(b) (i) Empilan LDE (t.m.) by Albright & Wilson - a non-ionic lauric diethanolamide (1:1), the equivalent of Lankrostat J.P. a solid block, much softer and less tractable than Lankrostat J.P.;

(ii) Empilan LDX (t.m.) by Albright & Wilson - lauric diethanolamide (diethanolamide to acid 2:1) solid block, even softer than Empilan LDE.

(c) REWO AMID DL 203/S by REWO Chemicals lauric diethanolamide (1:1 equivalent of Lankrostat J.P.) solid block, physical form less advantageous than that of Lankrostat J.P.;

(d) Marlamid D 1218 by Huls U.K. Ltd. - coconut diethanolamide liquid;

(e) Empilan GMS/SE40 (t.m.) a self-emulsifying grade of glycerol monostearate, from Albright & Wilson Ltd. in powder form.

The manufacturer's specifications were as follows:

Melting point 55-60 degrees

Density at 20 degrees C 0.5 g/cm^3

Total monoglyceride (min.) 36.0%

Free glycerol (max.) 7.0%

Iodine Value (max.) 3.0%

Acid Value (max.) 3.0%

Sodium stearate 5.6%

(f) Hostastat HS-1, (t.m.) an aliphatic sulphonate, from Hoechst U.K. Ltd. supplied as a granular powder.

The material is odourless and physiologically harmless (Commission on Plastics of the Federal German Ministry of Health).

The material is water soluble, (i.e. HLB 13).

(g) RS/B/10/2, Lankrostat JP (t.m.) to which 10% of Alusil AS (t.m.) a synthetically precipitated form of hydrated sodium aluminosilicate, from Crossfield, had been added.

(h) RS.B/11/2, Lankrostat JP (t.m.) to which 10% Speswhite China Clay, from English China Clays, had been added.

(i) RS/B/14/2 Lankrostat JP (t.m.) to which 10% Alusil AS (t.m.) had been added.

(j) RS.B/18/2 Lankrostat JP (t.m.) to which 10% Snowfloss, a diatomaceous (silica) from Johns-Manville had been added.

(k) Empilan CDE.FF (t.m.) coconut diethanolamide from Albright & Wilson in liquid form.

(l) Monamid 150 MW (t.m.) a myristic diethanolamide (1:1 ratio of diethanolamide to myristic acid) from Mona Industries was flaked and was then ground in a mortar.

Additional other suitable anti-static agents may comprise:

(i) Empilan LDE

(ii) Monamid 718

(iii) Grindtek PGE 55

Grindtek PGE 55/6

(iv) Empicol LQ 33T

(v) Volpo 05

(vi) Lubrol 17A10

(vii) Ethoquad C12

(viii) Texofor C1

(ix) Cithrol 10 MS

(x) Empigen OB

(xi) Grindtek CA-P

(xii) Crodateric C

(xiii) Ambiteric D40

(xiv) Crodasinic L

(xv) Crillet 3

(xvi) Ethocas 35

(xvii) Croduret 30

(xviii) Grindtek FAL-1

Bead was pre-expanded using the equipment shown in Figure 1 and 2 to carry out processes in accordance with embodiments of the invention, using EMPILAN LDE and MONAMID 150MW as the anti-static agents (See the Chart following).

Additive Ref.	Duration of Pre-Expansion*	Density of Beads ($lb./ft^3$)	Comments
(b) Empilan LDE	3 min. 43 sec.	4.35	Added to the sight glass, bead stored after pre-expansion
(b) Empilan LDE	2 min. 16 sec.	3.3	Lump, some beads remained on the pre-expander wall, stored after pre-expansion
(e) Monamid 150 MW	12 min.26 sec.	4.2	
(e) Monamid 150 MW	7 min. 1 sec.	6.3	
(e) Monamid 150 MW	5 min.54 sec.		

By way of additional example, 750 gm. of "Dylite" expandable polystyrene beads were added to a dry pre-expander (such as pre-expander number 34) followed by 3.8 gm of liquid Grindtek PGE 55 injected from a liquid dispenser maintained at 50°C. After 6½ minutes in the pre-expander at a maximum temperature of 105°C, pre-expanded beads having a density of 6.7 lbs. per cu.ft. were discharged into a storage hopper. The pre-expanded beads were moulded into cups using a steam heated/ injected multi-cavity mould and moulding machine, to give cone shaped cups weighing about 2½gm., which cups are easily released from the moulds. Cups when tested for anti-static properties showed no charge and no charge could be induced by stripping the cups from a stack or rubbing with nylon fabric or polyethylene foam at 25°C and 47% relative humidity. When the above process was repeated using zinc stearate in place of Grindtek PGE 55, the formed cups were readily statically charged to give a Codastat reading of -4000 volts., retaining -4000V a d -3500V, 2 minutes and 15 minutes respectively, after charging.

EVALUATIONS

On site evaluations of cups moulded from pre-expanded bead incorporating an anti-static agent carrying out the processes and using the equipment in Figures 1 and 2, were carried out in two stages.

FIRST SERIES OF TESTS

The first tests carried out on moulded cups consisted of the following measurements:

(a) average cup weight

(b) effect of water immersion - to check for porosity - the cups were immersed in a bucket of water, base upwards.

(c) static charge (without rubbing) measured using a Simco Electrostatic locator with all apertures open and the base of the cup 2 inches from the probe.

(d) filling of stacks of cups with powdered coffee and shaking.

Evaluations (a), (b) and (c) were carried out in the order of a,c,b, on sets of 10 cups. Evaluation (d) was carried out on different sets of 10 cups. (See Table below).

As some cups were less than 24 hours old, static charge measurement and dispensing trial (using powdered chocolate) were repeated on a number of sets of cups.

REFERENCE	MATERIAL	AVERAGE CUP WEIGHT	WATER IMMERSION	STATIC CHARGE
	Empilan CDE/FF	2.65 g.	No Leaks	0
batch 3				
batch 2		2.82 g.	No Leaks	0
batch 1		2.76 g.	No Leaks	0
	Empilan	3.47 g.		0
	Hostastat	2.76 g.	No Leaks	about 0
	RS/B/11/2	2.82 g.	No Leaks	0
	RS.B/10/2	2.98 g.	No Leaks	0
	RS/B/14/2	2.89 g.	No Leaks	0
	RS/B/18/2	2.82 g.	No Leaks	0
	Monamid 150-MW	3.10 g.		about 0
	Empilan LDE	2.60 g.	No Leaks	0

SECOND SERIES OF TESTS.

In the second series of tests, five selected groups from every

moulding trial, including freshly made zinc stearate production cups were stored for three days. The static charge of all the cups was measured by the Simco Electrostatic Locator (base of the cup, distance 2", all apertures open, no rubbing, scale -400+400V). The cups were filled with chocolate powder and the stacks of cups were examined after filling.

Conditions in the dispensing room as measured by Whirling Hygrometer were 23 degrees C 45% r.h.

REFERENCE	STATIC CHARGE	STICKING AFTER FILLING (CHOCOLATE)
Empilan LDE	0	Nothing
Empilan LDE	0	
	0	Slight
	0	
	0	
	About 0	
	10V	
RS/B/11/2	0	Nothing
Monamid 150-MW	0	Nothing
RS/B/18/2	0	Nothing
RS/B/10/2	0	Nothing - Slight
RS/B/11/2	0	Very Slight
Hostastat HS1	0	Slight
Empilan CDE/FF	0	Very Slight
Empilan GMS SE40	0	Nothing
Empilan CDE/FF (1)	0	Nothing
(2)	0	Nothing
(3)	0	Nothing
Lankrostat JP	0	Nothing

The experimental anti-static expanded polystyrene cups were moulded using about 0.5% lankrostat JP by weight of expandable polystyrene beads, when the beads were pre-expanded using the equipment shown in Figure 2. This quantity of Lankrostat JP gave good anti-static properties to the cups.

To investigate the distribution of the anti-static agent Lankrostat JP in the cups, three methods were used:

1. Soxhlet extraction with distilled water to examine the soluble material extractable from the surface of the cup.

2. Staining of the cup with a fluorescent dye (Eosin) and examination

of the fluorescence under ultra-violet light, using a standard zinc stearate-containing EPS cup as a comparison standard.

3. washing the surface of the cup with hot distilled water, followed by drying of the cup and checking of the charge and the acceptance of induced charge.

Tests and Results

1. Soxhlet Extraction

An accurately weighed piece of expanded polystyrene cup, containing about 0.5% by weight Lankrostat JP, was soxhlet extracted continuously for six hours in distilled water. The amount of material extracted was 0.13% by weight.

2. Staining and Fluorescence Examinations

A moulded cup containing Lankrostat JP and a cup containing zinc stearate, were immersed in a dilute solution of eosin, in distilled water, for 3 minutes at 55oC. The surfaces of the cups were then rinsed with distilled water and the extent of staining was examined under ultra-violet light at 300-400 nanometers (nm).

The Lankrostat JP cup leaked the eosin solution to the inside and where this occured, there was an even distribution of stain over the inside face. The outer surfaces of the cup was heavily and uniformly stained.

These tests appeared to indicate that the cup was uniformly coated by Lankrostat JP over both inside and outside surfaces of the cup. The cup containing zinc stearate was only very very lightly, though uniformly, stained.

3. Surface Washing.

The surface of a moulded cup containing Lankrostat JP was washed by immersion in distilled water at 80^{o}C for thirty minutes and the surface then dried at 70^{o}C for thirty minutes. Residual static charge measurements on the washed cup and attempts to induce charge,

measured by Codastat, were the same as on the original cup.

It appears from the evidence of all three tests that the Lankrostat JP is dispersed throughout the body of a moulded cup and is also present as thin surface layers. The anti-static performance appears not to be solely dependant on the surface layers, as adequate anti-static performance remains once the surface layers are removed.

Anti-Static Cups By Coating of Moulded Cups.

A preliminary test, made primarily in relation to the development of a film coating test method for assessing surfactant anti-static agents, showed that standard, zinc stearate containing, expanded polystyrene cups could be rendered anti-static by coating with a solution/dispersion of a suitable anti-static agent selected from the listed anti-static agents. For example, when a zinc stearate containing cup was coated by brushing on a 10% w/wt dispersion of Grindtek PGE55 (polyglycerol stearate/palmitate) in hexane, the cup became anti-static on drying and no charges could be induced by the standard test procedure, as measured by Codastat.

Evaluation (By Codastat) of Moulded Expanded Polystyrene Cups With Anti-Static Agent For Anti-Static Properties

Pre-test Conditioning: The test cups were placed 15 cm. apart on a clean, insulated, charge free, glass plate and conditioned at 25°C and 30% RH for 1 hour before test.

Static Charge Measurements: Six measurements were made on each test sample as follows:

1. Initial charge present, after conditioning
2. Charge induced after charging by rubbing with nylon fabric for 5 seconds
3. Charge 30 seconds after induction
4. Charge 2 minutes after induction
5. Residual charge after 17 hours
6. Residual charge after 21 hours.

Results are given in Table 1.

TABLE 1

TRADE NAME	INITIAL	STATIC CHARGE-VOLTS CONSTANT AFTER CHARGING	30 sec. DELAY	2 min. DELAY	17 hour RESIDUE	21 hour RESIDUE	PREVIOUS RESULTS (SIMCO) VOLTS
Empilan LDE	0	0	0	0	0	0	0
Empilan LDE	0	-400	-200	-200	0	0	0 to 10
Grindtek PGE 55	0	-600	0	0	0	0	0
Rs/B/11/2	0	-400	0	0	0	0	0
Monamid 150 MW	+200	-900	-600	-300	0	0	0
RS/B/10/2	0	-500	-200	-100	0	0	0
RS/B/11/2	0	-700	-600	-600	-200	-200	0
Hostastat HS-1	-200	0	0	0	0	0	0
Empilan CDE/FF	0	0	0	0	0	0	0
Zinc Stearate	-1000	-4000	-4000	-4000	-1200	-1200	-150 to 400
Lankrostat JP	-200	-600	-200	0	0	0	0

The following additional information is offered in respect of other tests conducted on moulded cups comprising one of the anti-static agents identified.

MOULDED CUP STATIC CHARGE MEASUREMENT RESULTS.

ANTI-STATIC ADDITIVE	CHEMICAL TYPE	INITIAL CHARGE VOLTS	CHARGE AFTER CHARGING VOLTS		
			IMMEDIATE CHARGE	CHARGE REMAINING AFTER 30 SECONDS	CHARGE REMAINING AFTER TWO MINUTES
Lankrostat JP	Lauric Diethanolamide	- 200	- 600	- 200	0
RS/B/11/2	Modified Lauric diethanolamide	0	- 400	0	0
Empilan LDE	Lauric diethanol -amide	0	0	0	0
Empilan CDE/FF	Coconut Diethanol-amide	0	0	0	0
Grindtek PGE 65	Polyglycerol Ester	0	- 600	0	0
Hostastat HS-1	Aliphatic Sulphonate	0	0	0	0

RESULTS ON COATED FILMS TEST AT 25°C AND AT STATED RELATIVE HUMIDITY

POTENTIAL ANTI-STATIC ADDITIVE	CHEMICAL TYPE	CHARGE AFTER CHARGING VOLTS: MAXIMUM	CHARGE AFTER CHARGING VOLTS: AVERAGE	CHARGE AFTER CHARGING VOLTS: CHARGE REMAINING AFTER 15 MINUTES
Lankrostat JP	Lauric Diethanol-amide	- 200	0	0
Monamid 150 MW	Myristic Diethanol-amide	0	0	0
Empilan GMS SE 40	Glycerol Mono Stearate	0	0	0
Crillet 3	Ethoxylated sorbitan mono Stearate	0	0	0
Hostastat HS-1	Aliphatic Sulphonate	0	0	0
Crodurct 30	Hydrogenated castor oil Ethoxylate	0	0	0
Lubrol 17A10	Cetyl/Oleyl Alcohol Ethoxylate	0	0	0
Empicol LQ 33T	Monoethanolamine Lauryl Sulphate	0	0	0
Ethoquad C12	Quaternised Coconut Amine Ethoxylate	0	0	0
Ambiteric D40	Dodecyl Dimethyl Betaine	0	0	0
Empigen OB	Amine Oxide B	- 200	- 200	0

Moulded cups, containing antistatic agents in the body of the cup tested in duplicate at 25°C and 54% Relative Humidity

MOULDED CUP STATIC CHARGE MEASUREMENT RESULTS.

ANTI-STATIC ADDITIVE	CHEMICAL TYPE	INITIAL CHARGE VOLTS	CHARGE AFTER CHARGING VOLTS: IMMEDIATE	CHARGE REMAINING AFTER 30 SECONDS	CHARGE REMAINING AFTER TWO MINUTES
Grindtek PGE 55	Polyglycerol Ester	0	0	0	0
Grindtek PGE 55	Polyglycerol Ester	0	0	0	0
Grindtek FAL-1	Stearoyl Lactylate	0	- 200	0	0
Grindtek FAL-1	Stearoyl Lactylate	0	- 200	0	0
Ambiteric D40	Dodecyl Dimethyl Betaine	0	0	0	0
Ambiteric D40	Dodecyl Dimethyl Betaine	0	0	0	0
Ethoquad C 12	Quaternized Coconut Amine Ethoxylate	0	0	0	0
Ethoquad C 12	"" ""	0	0	0	0
Empicol LQ 33T	Monoethanolamine Lauryl Sulphate	0	0	0	0
Empicol LQ 33T	"" ""	0	0	0	0
Empigen 08	Amine Oxide	0	- 200	0	0
Empigen 08	Amine Oxide	0	- 100	0	0
Crodasinic L	Lauryl Sarcosine	0	+ 200	0	0
Crodasinic L	Lauryl Sarcosine	0	+ 200	0	0
Monamid 150 MW	Myristic Diethanol Amide	0	- 200	0	0
Monamid 150 MW	Myristic Diethanol Amide	0	- 300	0	0
Croduret 30	Hydrogenated Castor Oil Ethoxylate	0	+ 1800	+ 1000	0
Croduret 30	"" ""	0	+ 1200	+ 200	0

MOULDED CUP STATIC (Containing Anti-Static Agent in the body of the cup) STATIC CHARGE MEASUREMENT RESULTS

MOULDED CUPS TEST (SOME IN DUPLICATE) 25°C and 47%R.H.

POTENTIAL ANTI-STATIC ADDITIVE	CHEMICAL TYPE	INITIAL CHARGE VOLTS	IMMEDIATE	REMAINING AFTER 30 SECONDS	REMAINING AFTER TWO MINUTES	REMAINING AFTER AFTER 15 MINUTES
Lankrostat JP	Lauric Diethanol-Amide	0	- 500	- 100	0	0
RS/B/11/2	"" ""	0	0	0	0	0
RS/B/10/2	"" ""	0	- 600	- 300	0	0
RS/B/10/2	"" ""	0	- 1000	- 800	- 400	0
Empilan LDE	Lauric Diethanol-Amide	0	- 300	0	0	0
Empilan LDE	"" ""	0	0	0	0	0
Empilan CDE/FF	Coconut Diethanol Amide	0	0	0	0	0
Monamid 150MW	Myristic Diethanol Amide	0	- 200	0	0	0
Monamid 150MW	"" ""	0	- 500	0	0	0
Monamid 150MW	"" ""	0	-1400	0	0	0
Monamid 150MW	"" ""	0	+1000	- 200	- 200	0
Monamid 150MW	"" ""	0	- 200	0	0	0
Crodasinic L	Lauryl Sarcosine	0	- 1000	- 200	0	0
Crodasinic L	Lauryl Sarcosine	0	- 400	- 100	0	0
Empilan GMS SE 40	Glycercol Mono-Stearate	0	- 400	0	0	0
Grindtek CA-P	Citric Acid Ester	0	- 100	0	0	0
Grindtek FAL-1	Stearoyl Lacty-late	0	0	0	0	0
Grindtek PGE55	Polyglycerol Ester	0	0	0	0	0
Grindtek PGE55	Polyglycerol Ester	0	0	0	0	0

Crillet 3	Ethyoxylated Sorbitan monostearate.	0	+ 1200	+ 400	+ 100	0
Crillet 3	"""" """"	0	+ 1200	+ 300	0	0
Hostastat HS-1	Aliphatic Sulphonate	0	0	0	0	0
Croduret 30	Hydrogenated Castor Oil Ethoxylate	0	+ 700	+ 300	+ 300	0
Croduret 30	"" """"	0	+ 2000	+ 700	0	0
Empicol LQ33T	Monoethanol-amine Lauryl Sulphate	0	0	0	0	0
Ethoquad C12	Quaternised Coconut Amine Ethoxylate	0	0	0	0	0
Ambiteric D40	Dodecyl Dimethyl Betaine	0	0	0	0	0
Epigen OB	Amine Oxide	0	- 100	0	0	0

SURFACTANT AS ANTI-STATIC AGENT

SAMPLES COATED FROM OILY SOLUTION

TRADE NAME	RELATIVE HUMIDITY DURING TEST	CHARGE VOLTS INITIAL	CHARGE VOLTS MAXIMUM	CHARGE VOLTS AVERAGE	CHARGE VOLTS AFTER 15 MINUTES
Lankrostat JP	26	0	- 200	0	0
Grindtek PGE 55	26	0	- 400	0	0
Empicol LQ 33T	25	0	0	0	0
Ethoquad C12	25	0	0	0	0
Texofor C1	25	0	- 200	- 200	0
Cithrol 10MS	25	0	- 300	- 300	0
Empigen OB	25	0	- 200	- 200	0
Tenlo 70	25	0	- 300	- 300	0
Marlamid 1218	41	0	0	0	0
Hostastat HS-1	41	0	0	0	0
Monamid 150MW	41	0	0	0	0
Empilan GMS Se 40	41	0	0	0	0
Grindtek Ca-P	41	0	- 400	- 200	0
Empilan BQ-100	34	0	0	0	0
Crodateric C	34	0	0	0	0
Ambiteric D40	34	0	0	0	0
Crodasinic L	27	0	- 500	- 300	0
Crillet 3	27	0	0	0	0
Volpo 05	27	0	0	0	0
Ethocas 35	27	0	0	0	0
Croduret 30	27	0	0	0	0

With reference to Figure 3, a schematic of part of moulding equipment generally shown at 100 is shown comprising steam inlet 102 leading into steam manifold 104 having condensate drain 106 carrying bleeder valve 108 leading to a drain (not shown). Liquid anti-static agent (Lauric Diethanolamide) is metered from storage 110 through metering line 112 into steam manifold 104 in an amount equal to about .5% by weight of the pre-expanded bead to be fully expanded into the final article (a cup) in mould 114. When the anti-static agent (Lauric Diethanolamide) contacts the steam, it vaporizes, atomizes or mists.

Outlet 116 leading from steam manifold 104 is shown leading into mould 114 past screw adjustable regulator 118 outside of conical portion 120 of mould 114. Surrounding outlet 116 leading into mould 114 is annular inlet 122 surrounding tube 116 for passing steam from tubing 121 for heating mould 114 through annular inlet 122 through annular tubing 122A.

Cover 124 is spaced from the outer surface 126 of portion 120 when secured therewith to present expansion chamber 128 between the outer surface 126 of portion 122 and the inner surface 130 of cover 124. Inlet 132 for re-expanded bead feeds pre-expanded bead (not shown) into chamber 128. As the bead is fed into chamber 132, it becomes coated with the misted vaporized or atomized anti-static agent which has filled chamber 128.

CLAIMS:

1. A combination of thermoplastic material and at least one anti-static agent suitable for use in association with comestibles selected from:

(a) fatty acid dialkylolamides
(b) higher fatty acid esters of polyglycerols
(c)(i) monoethanolamine lauryl sulphates
(c)(ii) lauryl ether sulphates
(d) higher alcohol ethoxylates
(e) quaternized ethoxylated amines
(f) fatty acid ester ethoxylates
(g) higher fatty acid esters of glycerol
(h) higher amine oxides
(i) aliphatic sulphonates
(j) citric acid esters of monoglycerides
(k) a 2-alkyl-1-[ethyl-betaoxypropanoic acid] -imidazoline
(l) alkyl dimethyl betaines
(m) lauroyl sarcosinates
(n) higher ethoxylate sorbitan esters of a higher fatty acid
(o) castor oil ethoxylates (ethoxylated castor oil)
(p) hydrogenated castor oil ethoxylates (ethoxylated hydrogenated castor oil)
(q) fatty acid esters of lactylates

2. A combination as claimed in Claim 1 wherein the anti-static agent was combined with the thermoplastic material in the form of beads before the beads of material had been pre-expanded by combining the agent in sufficient

amounts either:

(i) with the thermoplastic bead to be expanded prior to injection into a pre-expander and thereafter injecting the combination into the preheated pre-expander for pre-expanding the bead, or

(ii) with the bead shortly after injection of the bead into a preheated pre-expander for pre-expanding the bead.

3. A combination as claimed in Claim 1 wherein the anti-static agent has been mixed with the thermoplastic material in the form of unexpanded beads.

4. A combination as claimed in Claim 1 wherein liquid anti-static agent was injected in sufficient amounts into steam delivered to a moulding cavity of a mould for intermixing the anti-static agent which has vapourized, misted or atomized with bead material for coating the expanding bead.

5. A combination as claimed in Claim 1 wherein liquid anti-static agent was injected in sufficient amounts into steam delivered to a moulding cavity of a mould for intermixing the anti-static agent which has vapourized, misted or atomized, with pre-expanded bead for coating the expanding bead.

6. A combination as claimed in Claim 1, 2 or 3 wherein the thermoplastic material is in the form of unexpanded or pre-expanded beads coated with the anti-static agent.

7. A combination as claimed in any one of Claims 1 to 5 in the form of a substantially static-free article of cellular expanded or foamed thermoplastic material comprising beads of cellular expanded or foamed thermoplastic material moulded in the shape of an article.

8. A combination as claimed in Claim 7 wherein the surface of the article has been coated with the anti-static agent.

9. A combination as claimed in Claim 7 wherein the body of the article has the anti-static agent dispersed through its entire body.

10. A process of combining an anti-static agent with beads of thermoplastic material to be pre-expanded for use to manufacture a static-free article of cellular expanded or foamed thermoplastic material or to be fully expanded into a static-free article of cellular expanded or foamed thermo-

plastic material, the anti-static agent being suitable for use with comestibles and being combined in sufficient amounts either:

(a) with thermoplastic beads to be expanded prior to injection into a pre-expander and thereafter, injecting the combination into the pre-heated pre-expander for pre-expanding the beads

or

(b) with the beads in a pre-heated pre-expander shortly after injection of the beads into the pre-heated pre-expander for pre-expanding the beads

or

(c) in liquid form, with steam for delivery to a moulding cavity of a mould for intermixing with pre-expanded beads for moulding into the final article,

whereby the anti-static agent upon contacting the heated environment is misted, atomized and/or vapourized filling the space of the environment, uniformly coating the beads, rendering the material anti-static.

11. A process as claimed in Claim 10 wherein the anti-static agent is in liquid form.

12. A process as claimed in Claim 10 wherein the anti-static agent is in solid form.

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13. A process as claimed in Claim 12 wherein the anti-static agent, prior to the application of heat is maintained at a temperature below that at which it becomes sticky.

14. A process as claimed in any one of Claims 10 to 13 wherein the anti-static agent is combined in a proportion of at least 0.1% by weight of the beads.

15. A process as claimed in any one of Claims 10 to 14 wherein the anti-static agent is combined in a proportion of up to 5% by weight of the beads.

16. A process as claimed in any one of Claims 10 to 13 wherein the anti-static agent is combined in a proportion of from 0.2 to 2% by weight of the beads.

17. A process as claimed in any one of Claims 10 to 16 wherein the anti-static agent is selected from:

(a) fatty acid dialkylolamides
(b) higher fatty acid esters of polyglycerols
(c)(i) monoethanolamine lauryl sulphates
(c)(ii) lauryl ether sulphates
(d) higher alcohol ethyoxylates
(e) quaternized ethoxylated amines
(f) fatty acid ester ethoxylates

(g) higher fatty acid esters of glycerol

(h) higher amine oxides

(i) aliphatic sulphonates

(j) citric acid esters of monoglycerides

(k) a 2-alkyl-1- [ethyl-betaoxypropanoic acid] - imidazoline

(l) alkyl dimethyl betaines

(m) layroyl sarcosinates

(n) higher ethoxylate sorbitan esters of a higher fatty acid

(o) castor oil ethoxylates (ethoxylated castor oil)

(p) hydrogenated castor oil ethoxylates (ethoxylated hydrogenated castor oil)

(q) fatty acid esters of lactylates

18. A cup or container in the manufacture of which anti-static agent and thermoplastic material has been combined by a process as claimed in any one of Claims 10 to 17.

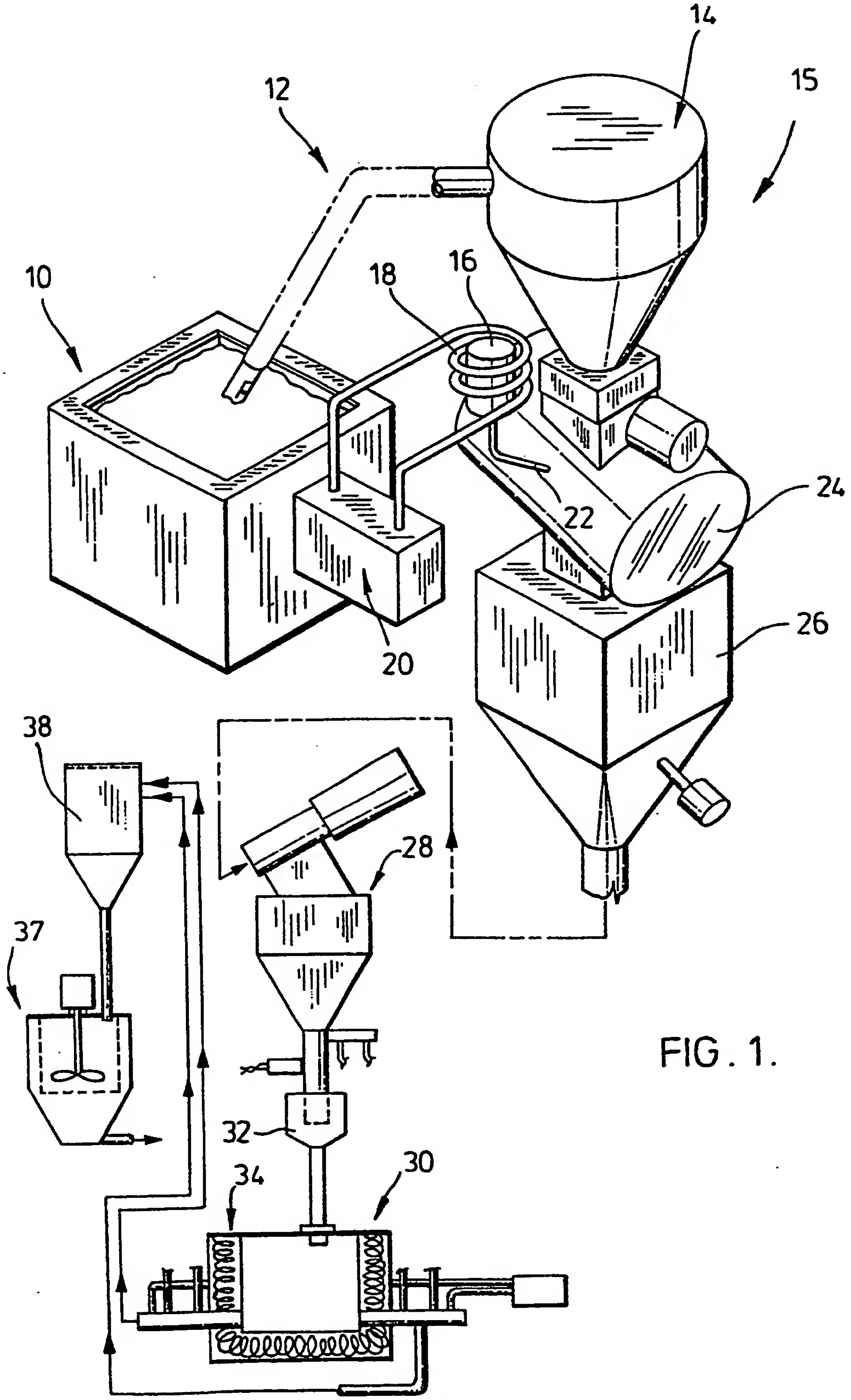


FIG. 1.

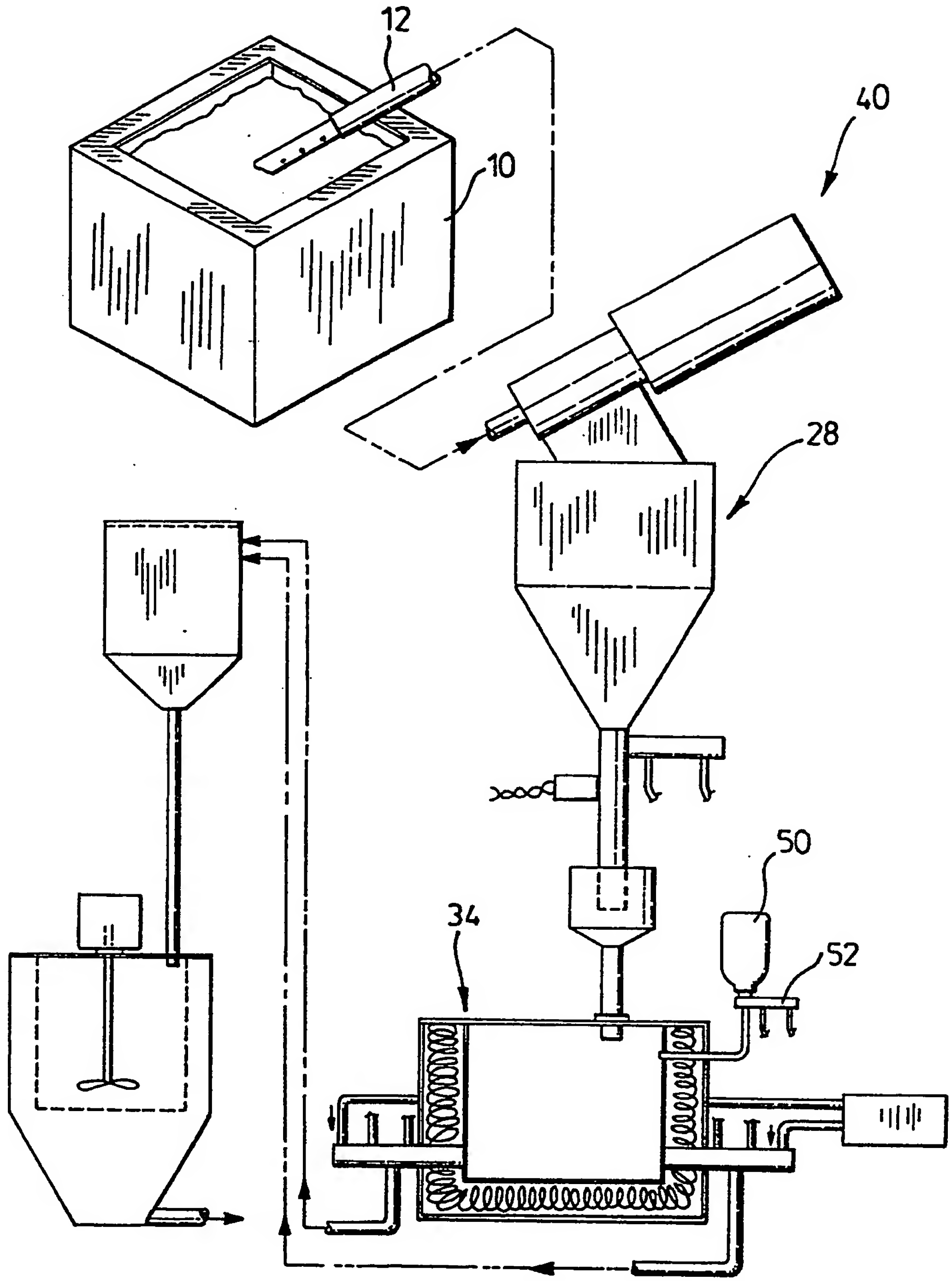
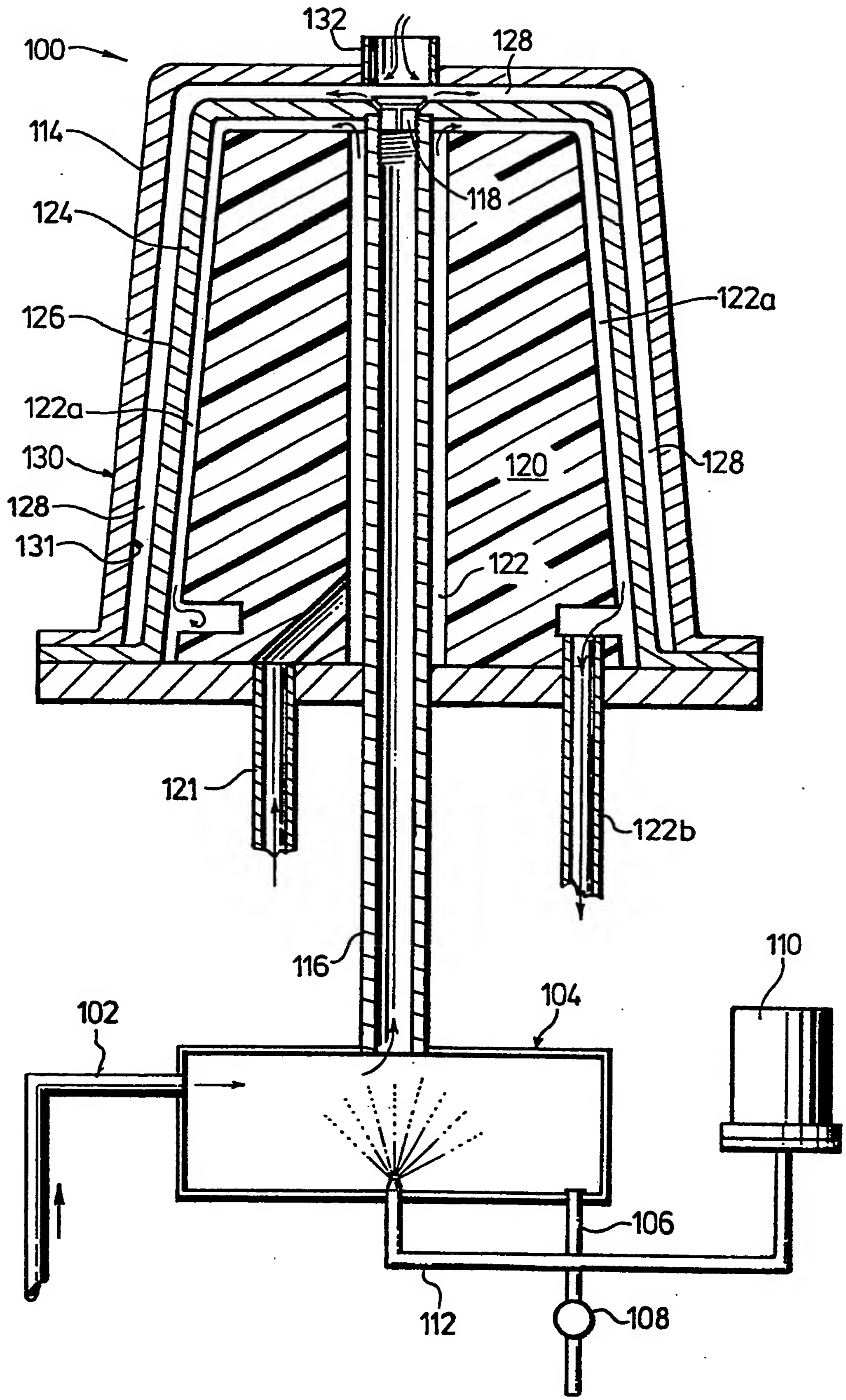


FIG. 2.

FIG. 3.


132
128
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122a
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122a
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122b
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108